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Distributivity and Agreement mismatches in Serbian

Abstract: This paper presents a truth value judgment study done on two types of numerals in the Serbian numerical system and corresponding verbal agreement mismatch that is characteristic for the numerals in question. Recent work on agreement and distributivity suggests that singular verbal marking promotes distributivity while plural marking can be interpreted as both distributive and collective. Serbian informants showed opposite intuitions – singular suggests collectivity and plural marking denotes distributivity. Given the highly inflectional nature of the Serbian language, we were interested in investigating to what degree verbal agreement influence interpretation preferences. Two types of numerals – paucal and mixed-gender – were used with singular and plural verbal agreement. Adults and 7-year-old children showed no correlation between verbal agreement and collective/distributive interpretations. Adults accept collective readings and disprefer distributive ones, while children accepted both distributive and collective readings for all sentence forms, even at age seven. We propose a follow up study that will take cognitive load into account and test whether increased load can cause this drastic difference between adults and children.

Keywords: distributivity, collective, agreement mismatch, numerals, verbal agreement, truth value judgment, paucal, mixed-gender, cognitive load

1. Introduction

Syntax and formal semantics have been dealing with the notions distributivity and collectivity for decades. At the same time, developmental psycholinguistics has focused on how children comprehend quantifiers and numerals, given that this is one of the main areas of non-adult behavior (Brooks and Braine, 1996; Drozd et al, in prep; Syrett and Musolino, 2013). Considering numerical quantifiers, for instance, in sentences with two numerically quantified NPs like “Three clowns are holding a present”, two prominent interpretations are collective (Fig 1.a) and distributive (Fig 1.b) (Musolino, 2009):



Figure 1.a: Collective



Figure 1.b: Distributive

Crosslinguistically, it has been shown that English adults and children differ greatly from Serbian adults and children in Truth Value Judgment experiments with numerically quantified sentences (Knežević, 2012; Knežević, 2015). English adults accepted both interpretations, preferring collective pictures, while Serbian adults rejected distributive pictures. Results from children show that five-year old English children behaved like adults at this age. However, Serbian children differed from Serbian adults and English participants (Musolino, 2009; Knežević, 2012) in accepting distributive readings, and rejecting collective readings about half the time. The percentage of YES-responses of numerically quantified sentences without overt distributive markers (e.g. “Three boys are holding two balloons”) is presented in Figure 2.

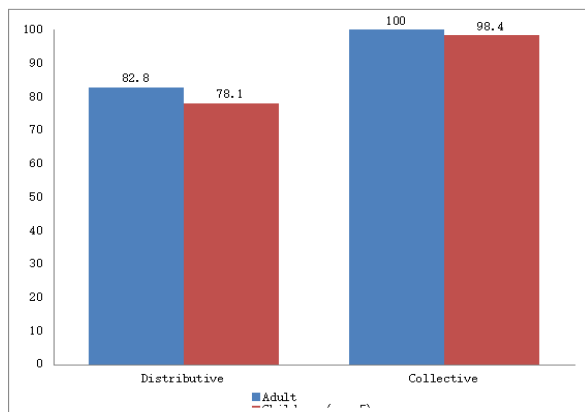


Figure 2.a: Percentage of YES responses
(Musolino, 2009)

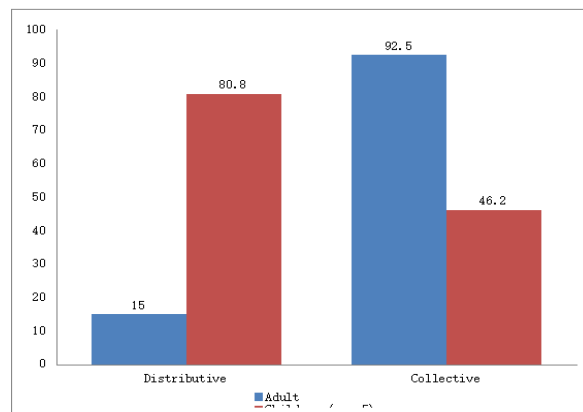


Figure 2.b: Percentage of YES responses
(Knežević, 2012)

Recent research suggests that Serbian children are not sensitive to distributive markers until the late age of 8 or 9 (Knežević, 2015), which makes the results in Figure 2.b unexpected because children prefer distributivity. On the other hand, their English speaking counterparts, readily accept both interpretations. We are interested in explaining why is it the case that children consistently choose distributive reading in the period when they have not completely acquired distributive markers.

One of the most obvious differences between Serbian and English is that Serbian is highly inflected. Serbian has several types of numerals which trigger either singular or plural verb agreement in environments with numerically quantified expressions. This difference may account for the disparity in English and Serbian child and adult results. In particular, does subject-verb agreement play a role in the development of the interpretation of distributivity in Serbian children? Therefore, our aim is to look closely into the morpho-syntax of Serbian to uncover cues and markers children and adults are sensitive to and which ones dictate the preference or rejection of certain interpretations.

In the following Section we introduce the properties of Serbian morpho-syntax relating to numerals and subject-verb agreement. Then we explain our predictions as to how this might influence distributivity interpretations in Section 3. In Section 4 we present our experiments, methods and results with Serbian adults and children. Section 5 includes the discussion about the results and the lack of correlation between verbal agreement and distributive/collective preferences, focusing on scalar implicatures as a possible explanation. We make conclusions in the Section 6 and make suggestions for further research, including proposing testing the effect of cognitive load in adults cognitive unload in children on interpretational preferences.

2. Theoretical Background

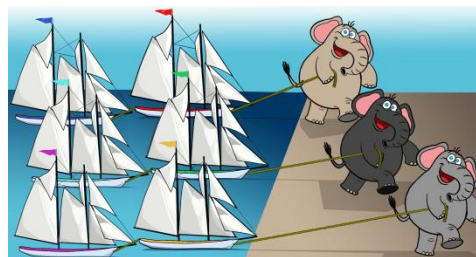
2.1. Numerical quantification

Work on numerals reveals an intricate system of possible interpretations. Musolino (2009) argues there are at least four possible interpretations of a sentence with two numerically quantified NPs and mixed type of predicate,¹ but only two are relevant for the current work. The basic distinction is the scopal relation between these NPs. These two relations, one scopal and one non-scopal, can be illustrated as follows (1):

- (1) “Three elephants are pulling two boats”.



3.a. Collective (Non-scopal)



3.b. Distributive (Scopal)

Scopal relations have to do with which NP (subject or object) takes scope over the other:

Distributive: Subject NP “elephants” takes scope over the object NP “boats”. That means that the Subject NP is a fixed expression, “three elephants”, and it requires the object NP to be distributed over each individual in the set of elephants (known as Subject-wide scope readings). The Object NP is therefore what is being distributed, in this case “two boats”. The interpretation becomes distributive and that entails a total of three elephants who are pulling two boats each, with a total of six boats (3.a)

Non-scopal relations do not depend on NPs taking scope over other NPs, and both NPs are interpreted independently, creating different relations between the members of sets:

Collective: Since both Subject and Object NPs are interpreted individually, each member of the set of “elephants” is connected to all members of the set of “boats” (known as Each-All readings). This interpretation is seen as collective and it entails a total number of three elephants pulling together a total number of two boats (3.b).

Previous research has shown that Serbian adults prefer collectivity when distributive markers² are not overtly present in numerically quantified sentences, whereas Serbian children behave non-adult-like by accepting distributivity at a higher rate. On the other hand, in studies with distributive markers (*each* and *every*), English children seem to be insensitive to distributive markers until the age of 5, because they incorrectly accept other interpretations (e.g. cumulative) (Drozd and Van der Lely, 2014). Furthermore, in the case of Serbian, acquisition of a distributive marker *po* is even later, with children accepting collective readings with *po* and preferring distributive interpretations consistently with collective pictures until the age of 8.

So the obvious question arises – why do children choose and prefer distributive interpretation?

¹Researchers also distinguish purely distributive and purely collective predicates (verbs). Distributive predicates (*sing, wave, clap, sleep*) can be modified by distributive markers, or they can be split into individual members of the set. Collective predicates (*gather, meet, share*) cannot be modified by distributive markers and must have plural definites. In other words, if a predicate P refers to every x from a set X, then P necessarily applies to X (it is distributive). However, if P refers to X as a whole set, it does not necessarily apply to every x from X (it is collective). (Champollion, 2014; Stanojević & Ašić, 2006):

1) The women waved => Every woman waved/ A woman waved. – distributive predicate

2) The women gathered => *Every woman gathered/ *A woman gathered. – collective predicate

The ambiguity, however, comes from the third type of predicate, called mixed predicate. The distinction is not straightforward, and every relation between predicates and the sets or members of the set is possible. Mixed predicates are neither inherently collective, nor inherently distributive

² We use the term “distributive marker” since not all quantifiers are distributive, nor all distributive markers are quantifiers. Different markers are available to force this distributive interpretation – adverbials, inflections, particles, etc. (Gil, 1995). For instance, Serbian has a multi-use morpheme “*po*”, Tlingit, an Alaskan endangered language, has the distributive marker “*gaa*” (Cable, 2014) and German has a distance-distributive quantifier “*jeweils*” (Zimmermann, 2002).

In our view, Serbian children may be sensitive to morphological marking before they understand the semantics of overt distributive markers and that is the reason they respond differently than adults. Ouwayda (2014) has suggested that verbal agreement might influence interpretation preferences for distributive and collective readings. Applying this intuition to Serbian, it might be that a plural verb encourages a distributive reading. The motivation for this hypothesis is covered in steps in the following sections.

2.2. Numerals in Serbian

The numerical system of Serbian has been a subject of much syntactic and morphological research because of its complexity of declension and agreement properties. Cardinal numerals are classified into several types: (i) basic cardinal numerals, (ii) collective (mixed-gender) numerals, (iii) numerical nouns and (iv) numerical adjectives. Each type comes with specific restrictions and different morpho-syntactic properties due to the type of noun they quantify (Stanojević, 2008). They also express case, gender and verbal agreement mismatches, creating an intricate system that can affect the syntax-semantic interface. However, we will focus only on types (i) and (ii), which are the central part of this paper.

Basic cardinal numerals are numerals like one, two, three, but in Serbian (*jedan, dva, tri*) they have different phi-features assigned to them due to the high inflectional nature of the Serbian language. Within basic numerals, 2, 3 and 4 create a closed set of numerals that have completely different forms from the rest. These numerals refer to small quantities, and are said to express so-called “minor plural” or paucal.

Paucal numerals differ from other numerals (1 and 5+) in phi-features and case features of the modifying noun. In English or Dutch, nouns would be in their plural forms when they combine with numerals greater than 2, but not in Serbian. Nouns take a special form, neither singular nor plural, when they are modified (or quantified) by numerals 2, 3 and 4 (2). The noun is said to have a paucal form but it shares some features with genitive singular (Piper et al, 2005).³ Having this in mind, there is a hypothesis that this apparent singularity of nouns with numerals 2, 3 and 4 yield distributive readings (see section 3):

(2) a) Jedan one.nom.masc	slon elephant.nom.sg.masc
b) Dva/ tri/ četiri two.nom.masc/ three/ four	slon- a /*slon- ova elephant.pauc.masc/*elephant.gen.pl.masc
c) Pet five	slon- ova elephant.gen.pl.masc

Collective (mixed-gender) numerals, such as *dvoje* (two), *troje* (three), *četvoro* (four), refer to the number of members in sets which contain individuals of both sexes, hence the term “mixed-gender”. To combine with these numerals the modified noun must refer to a group of animate individuals containing both sexes, so it is possible to say *dvoje dece* (two children) or *dvoje studenata* (two students; one has to be a girl and the other has to be a boy), but not **dvoje devojaka* (two girls) or **dvoje stolova* (two tables) (Stanojević, 2008). What is more, mixed-gender numerals can take either singular or plural verb.

2.3. Agreement mismatches in Serbian

The complex numerical system of Serbian may result in Agreement mismatches with other parts of speech. Nouns, adjectives and verbs have to agree in all phi-features (person, number and

³ Even though this is the case, paucal form cannot be treated the same as genitive for several syntactic and semantic reasons. The most apparent reason is agreement with determiners and adjectives which reveals different inflections for paucals and genitive singular (Belić, 2008).

gender) and case feature.⁴ Serbian also distinguishes between natural and grammatical gender. Although the majority of cases agree in all the features and grammatical gender usually coincides with natural gender,⁵ there are exceptions, and these are the cases of mismatches.

In this paper, we are focusing on paucal numerals and mixed-gender numerals and instances of verbal agreement that apply to them. Paucal numerals, for example, have both plural agreement and paucal agreement (3).

- (3) Tri dečaka su gledala/ ?su gledali film.
Three(paucal) boy.pauc is.pl.aux watch.past.pauc/ ?is.pl.aux watch.past.pl.masc movie.acc

Masculine gender agreement in (3), which is the expected semantic agreement due to the masculine feature of *boys*, is marginal in this case, putting syntactic agreement as the default agreement.⁶ Furthermore, a verb can also agree with the numeral *tri*. Since the numerals have no gender, it has to be neuter singular and, therefore, the sentence yields singular verbal agreement (4):

- (4) Tri dečaka ?je gledalo film.
Three(paucal) boy.pauc ?is.sg.aux watch.past.neut movie.acc
“Three boys were watching a movie.”

Among the three possible verbal agreement options, paucal numerals attract paucal agreement more than semantic agreement or the agreement with the numeral, which is the least common one. All three are, however, available. When it comes to mixed-gender numerals, there are two agreement options – agreement with the numeral and agreement with the NP, both equally available. Consider (5):

- (5) Troje Štrumpfova je gledalo/ su gledala film.
Three(mixed) Smurf.gen.pl is.sg.aux watch.past.sg.neut/ is.pl.aux watch.past.pl.neut movie.acc
“Three Smurfs were watching a movie.”

While it is expected that the verb agrees with the semantics (quantified expression) and syntax (genitive plural) of the noun, singular verbal agreement (the agreement with the mixed-gender numeral *troje*) is the default agreement (Šarić, 2014). Plural verbal agreement is marked as marginal not because it is border-line grammatical, but because it is less common, which contrasts the pilot study.⁷

⁴ Serbian has seven cases (Nominative, Genitive, Dative, Accusative, Vocative, Instrumental and Locative) and three declensions, each with their own inflections and exceptions. The overview and details about Serbian nominal and case system go beyond the scope of this paper.

⁵ The book *Many faces of Agreement* (Wechsler and Zlatić, 2003) gives a more detailed syntactic and semantic overview of mismatches in Serbia (one famous example is a mismatch between natural and grammatical gender: diminutive for *girl* can be either *devočurak* or *devojče*. Natural gender of these nouns is feminine, but *devočurak* is masculine and *devojče* is neuter.)

⁶ In the experiment we used singular and paucal agreement for paucal numerals, given that the paucal agreement behaves as the default one. However, we refer to paucal agreement as plural for simplicity and for the sake of comparison to mixed-gender cases. The fact we do this, doesn't interfere with our judgements about collectivity and distributivity.

⁷ In a pilot study, 106 Serbian adults (mean age: 25:9) were asked to give 5-point Likert scale ratings on the naturalness of sentences with numerically quantified NPs in present tense. The factors tested were the influence of numerals and gender. We used feminine (*devojičica* (girl), *devojka* (young-adult girl), *žena* (woman), *drugarica* (girl-friend), *sestra* (sister)) and masculine nouns (*dečak* (boy), *momak* (young-adult boy), *muškarac* (man), *drug* (boy-friend), *brat* (brother)) with basic (paucal) numerals *dva* (two), *tri* (three) and *četiri* (four). As target items we used mixed-gender nouns (*deca* (children), *studenti* (students), *ljudi* (people), *učenici* (pupils), *roditelji* (parents)) with mixed-gender numerals *dvoje* (two), *troje* (three) and *četvoro* (four). Pair tests showed that all potential interactions were significant ($p < 0.001$ for all except for f-sg and m-sg, which was $p < 0.02$) (Bosnić, 2015):

Mixed-gender numerals usually attract collective interpretations⁸, hence the term *collective numerals*, and their default verbal agreement is singular. These observations then suggest that verbal agreement might play a role in the interpretation preferences of ambiguous sentences.

Having covered some of the relevant properties of numerical quantification, numerals and agreement, we can proceed with our predictions and hypotheses regarding the interpretations and morphological cues in Serbian that we use in our experiments.

2.4. Morphological markedness

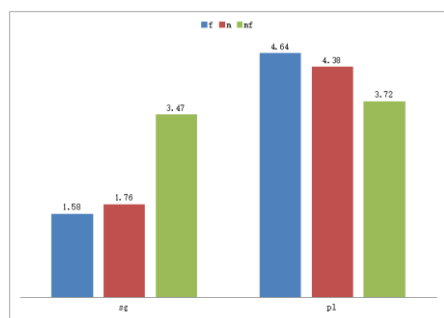
Within synthetic morphology languages there are highly inflectional languages, such as Serbian or Russian for instance, and languages with weaker or simpler inflectional systems, such as English and Dutch. We can also say that the former type has more morphological markedness than the latter. When it comes to language acquisition and its correlation with morphological markedness crosslinguistically, there are, as expected, discrepancies in the process of acquiring certain highly or weakly marked forms.

Rich morpho-syntactic forms in a language may cause acquisition to go either way. Studies were done investigating the impact of markedness and rich systems across languages which revealed interesting crosslinguistic variation. In an extensive study about Aspect in 12 European languages, it was shown that the meaning of (highly) marked forms (Slavic and Romance languages) is learnt and understood earlier than unmarked forms (Germanic languages, English in particular) (Van Hout et al, in prep). Veerle van Geenhoven (2006) also argued in favor of the view that rich inflectional system contributes to earlier learning - "...given that in English inflection often contributes aspect and tense information, we can ask whether English learning children lack the cognitive capacity to deal with time and to understand the ways in which time is integrated into language."

This research suggests that morphology affects acquisition and possibly interpretive skills. Hence we suggest that verbal marking in Serbian could be related to the acquisition of quantification and cognitive skills that its processing involves. Looking at morphologically rich languages (agglutinating or polysynthetic) gives more variables to analyze and more markers to test. Young learners of such languages are being exposed to complex morpho-syntactic systems and input at a very young age, which often results in them being sensitive to small and delicate distinctions in languages (Van Geenhoven, 2006).

3. Morpho-syntax and Distributivity

Considering everything mentioned above, we can now make two general predictions on how morpho-syntactic properties might influence preferences for collective and distributive readings: (i) verbal agreement correlates with the distributivity vs. collectivity opposition and (ii) nominal inflections are influencing interpretation preferences and can disambiguate sentences. Let us first clarify our motivation for these claims.



There is a significant preference of male nouns/plural verbal agreement than for male nouns/singular agreement. More importantly, it is interesting to see that mixed-gender nouns (mf) score is high for both agreements but not at ceiling, suggesting that it is possible that both options are equally possible but it is not formally described.

⁸ It is also mentioned in the pilot study by Knežević (2012) that children choose collective pictures more with mixed-gender numerals, and distributive with paucals.

- (i) Existing research on verbal agreement (and distributivity) offers a proposal that singular verb agreement suggests distributivity (Drozd & Van der Lely, 2014) and that singular predicates range over atoms (Winter, 2002). This claim has also been made about Lebanese Arabic by Ouwayda (2014), who suggested that singular verbal agreement will yield distributive readings, while plural will yield collective readings.⁹

However, there is evidence that plural agreement is triggered when the predicate is distributive (i.e. triggering semantic agreement) (Wechsler, 2009). Moreover, according to studies on agreement production in several languages, more plural verbs were produced for distributive noun phrases (*the label on the bottles*, for instance) than singular verbs (Haskell, 2003). Haskell further states that in “the constraint-satisfaction approach, the distributive sense promotes a plural verb while the collective sense promotes a singular verb, with the contribution of each depending on the relative dominance of the distributive or collective sense”. In other words, this proposal claims that singular verbal agreement implies a single action or activity happening at a given time, while plural verbal agreement implies that the same action is performed at the same time by multiple agents. Therefore, a singular verb form means a single joint action performed by all the members of the group designated by the subject.

- (ii) Also relevant is that one of Knežević’s explanations that the difference between Serbian and English speakers in Figure 2 relates to the notion of singularity. So far we have shown that paucal numerals modify the noun which then has a paucal number, and which is formally (Piper et al, 2005), but wrongly¹⁰, seen as singular. Knežević (2012) argues that it could be the noun in its paucal (that in this case only seems like it is genitive singular) form that is restricting the interpretation to distributive since singularity could relate to distribution over atomic individuals (Knežević, 2012). In addition, in her pilot study, Knežević tested paucal numerals and mixed-gender numerals and saw a tendency for children to accept distributive pictures with paucals and collective pictures with mixed-gender numerals. That lead her to assume that nominal inflection influences this choice – paucal form of the noun is attracting distributivity and the plural form of the noun with mixed-gender numerals is attracting collectivity.

The goal of our experiments was to determine which of these hypotheses apply and which cue is prominent in choosing a particular interpretation in numerically quantified sentences. To control for nominal inflections and verbal agreement we had to address one matter in the experiment with paucal numerals. Namely, we wanted to have a clear morphological indicator that the noun modified by the numeral overtly shows its paucal features. The nouns for the experiment were carefully chosen to meet this criterion. This means that the nouns used had a clear and overt morphological form of paucal case distinct from genitive plural case. To illustrate, compare the following examples (6):

- | | | | | |
|-----|------|-----------------|--------------------|-------------------|
| (6) | Boy: | Nom.sg: 1 dečak | Pauc: 2,3,4 dečaka | Gen.pl: 5+ dečākā |
| | Dog: | Nom.sg: 1 pas | Pauc: 2,3,4 psa | Gen.pl: 5+ pasa |

Paucal and genitive plural form of the noun “boy” only differ in vowel length. We wanted to avoid that and to explicitly show participants a different morphological form, that is, as already discussed, the same as genitive singular. The purpose of this was to put these nominal inflections against verbal agreement and see which indicator is stronger for a particular interpretation. Let us illustrate how this would work:

- | | | | | | |
|-----|-----------------------------------|----------|------|----------------|----------|
| (7) | Tri | psa | su | vukla | kolica. |
| | Three(paucal) | dog.pauc | were | pull.past.pauc | cart.acc |
| | “Three dogs were pulling a cart.” | | | | |

Here we have conflicting marking – singular-like feature on the noun and plural (paucal) on the verb. Should it be the case that this example yields distributive reading, nominal inflection is a

⁹ In the case of Lebanese Arabic, plural agreement is said to yield both collective and distributive reading (Ouwayda, 2014).

¹⁰ Despić (forthcoming) argues that paucal cannot and should not be formally seen as singular because it does not share the same number features as singular, although they are syncretic in form.

dominant marking to which speakers are more sensitive to; if the opposite is true, then the stronger marker is the number feature on the verb.

We have designed and conducted two experiments and tested Serbian adults and Serbian children. The method and results are covered in the following section. We did, however, assume that verbal agreement would be a stronger marker for distributivity rather than nominal inflections, being more striking and prominent than paucal features in the sentences.

4. Agreement experiments

Two Truth Value Judgment task (TVJT) experiments were conducted to test whether verbal agreement has an effect on the choice between the collective and distributive readings of numerically quantified sentences in Serbian. The two experiments differ¹¹ in the type of the numeral (and therefore, type of noun) used – between paucal (Experiment 1) and mixed-gender numerals (Experiment 2).

Participants:

Experiment 1: 38 Serbian adults (mean age: 26.9) (Experiment 1a) and 25 native Serbian children (12 girls/13 boys; mean age: 7;6) (Experiment 1b).

Experiment 2: 32 Serbian adults (mean age: 25.1) (Experiment 2a) and 24 native Serbian children (11 girls/13 boys; mean age: 7;7) (Experiment 2b).

Adults who declared themselves as linguists and/or bilingual were excluded from the analysis in order not to affect the results with these additional variables.

4.1. Method and Procedure

Both Experiment 1 (a and b) and Experiment 2 (a and b) were TVJTs and had a 2x2 balanced design, with 24 target items and 24 control items, in 4 lists. The participants were asked to determine whether the given sentence accurately described the given picture. The experiments were available online and adult participants completed the experiment independently online.

Children were tested individually with the experimenter present. Each participant took 5-7 minutes to complete the test independently, since they could select responses alone, on a touch-screen laptop. The experimenter gave the following instruction to the children: “*We have a program that mixed up some of the pictures and sounds. We need your help to sort them out. All you need to do is to select YES if you think the combination is correct and NO if you think it is wrong.*” Adults had the instructions available on the website, but not in the child-like manner as shown above.

Target items: 4 different verbs and 4 different nouns were used with 24 different objects to create target items. The verbs used were of a mixed type, very typical to these types of studies, with clear relational ambiguity (*carry, hold, push and pull*). The nouns used for Experiment 1 are: *pas* (dog), *slon* (elephant), *vanzemaljac* (alien), *klovn* (clown)¹², all showing different morphological inflections in paucal and genitive plural case (section 3) (8a).

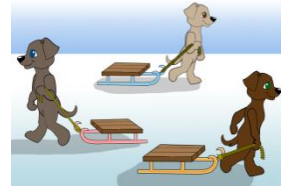
For Experiment 2 we had to select nouns that are plural, mixed-gender nouns, in order to satisfy the criteria of mixed-gender numerals. The nouns in question were: *deca* (children), *ljudi* (people), *Štrumpfovi* (Smurfs), *vanzemaljci* (aliens)¹³. In the case of aliens, we used two male and one female alien to justify the mixed gender feature (8b) (See appendix C for a complete list of target sentences).

¹¹ The other noteworthy difference is the tense used for the experiments. Since the naturalness test showed equal acceptance of both singular and plural verb on mixed-gender numerals in present tense, we used present tense in the mixed-gender TVJT. For the paucal TVJT we used past tense, since the preliminary judgements for paucals with singular and plural verb in past tense were not as clear as for the present tense. It is very important to note that past tense is also marked for gender, which is not controlled in this experiment, but it can have a significant effect of the grammaticality of the sentence. This, however, exceeds the scope of this paper and it will be dealt with in later studies.

¹² It is important to note one thing that made this experiment unbalanced – the length of syllables in nouns used. Namely, the fact that one noun is considerably more longer (*vanzemaljac*) than other three (*pas, slon* and *klovn*) could have an effect on agreement and possibly cognitive load required to process longer and more demanding nouns (Arsenijević, p.c). However, in our opinion, and given the results, this flaw in the experiment did not affect the core purpose of it – distinguishing between collective and distributive readings. Indeed, it could have had an effect on the agreement preferences, however this instance was not tested here.

¹³ Boban Arsenijević (p.c. 2016) points out specific features of certain mixed-gender nouns chosen for this experiment: the problem emerges with the noun “*deca*” which is not a true mixed-gender noun, because its semantics does not have semantic gender. It is actually a hybrid noun with different properties (syntactically feminine singular and semantically plural, and can be compatible with either sex) and without a direct morphological singular, which was also the problem with the noun “*ljudi*” (see Alsina & Arsenijević, 2012). These properties could have interfered with the experiment and results for these nouns. Another conflicting issue could have been the number of syllables as it was the case with the paucal experiment.

(8) a)

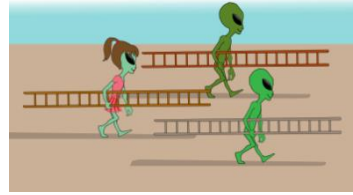


Tri psa je vuklo/su vukla sanke.

“Three dogs was pulling/were pulling a sledge.”

- One combination (out of 4 possible) per participant.

b)



Troje vanzemaljaca nosi/nose merdevine.

“Three aliens is carrying/are carrying a ladder.”

- One combination (out of 4 possible) per participant.

Control items: We counterbalanced Experiment 1 and Experiment 2 experiments with 24 control items. They had a larger number of NO responses to avoid the YES-bias for children. Another purpose these items had was to control if the children were paying attention so they were completely unambiguous, unrelated and clear (9).

(9)



Slon pere žirafu.

“Elephant is washing a giraffe.”

- clear NO answer

4.2. Results

Generalized logistic mixed effect models¹⁴ (Baayen et al, 2008) and random slopes were used for analyzing all the results (see Appendix A and B for the complete best final models). We tested the maximal model first in a stepwise fashion. General observations from the models given in Appendixes A and B are that adults are significantly less likely to accept distributive pictures matched with either singular or plural verb than children, and less likely to accept singular verbal agreement. Neither experiment showed significant correlations between verbal agreement and collective/distributive interpretations. The results are presented and described in the following sections.

¹⁴ *glmer* function; R version 3.1.2; Copyright © 2014

4.2.1. Experiment 1, Paucal numerals – Adults and children

Adult and child responses differ greatly in that adults rejected while children accepted distributive pictures (Figure 3 – YES responses). Paucal experiment revealed that adults are less likely to accept verb in singular (Est: - 1.154; $p < 0.000$), which is in line with the results from the naturalness study, in which singular verbal agreement is not preferred and it is considered ungrammatical. More strikingly, adults are significantly less likely to choose distributive pictures (Est: -9.521; $p < 0.000$), which is not the case with children (Est: 2.677; $p < 0.255$). In Experiment 1, we do see that children are have more adult-like responses, since there is a preference for collective pictures. To an extent, this is expected, since they are older children (7-year-olds), and given the child data of three age groups (5-, 7- and 9-year-olds) Knežević (2015) collected for her studies, children slowly and gradually start rejecting distributive pictures (because they are becoming aware of the role of distributive markers). However, when asked, children gave a reason for their rejection of distributive pictures in Experiment 1 – it still has nothing to do with overt distributive markers, but with the singularity of the object (see section 5).

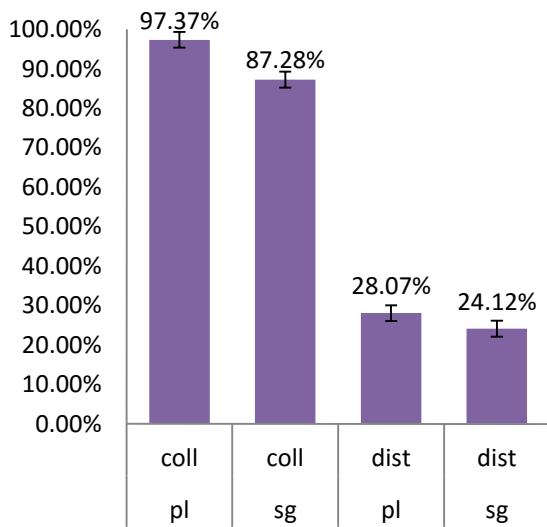


Figure 4.a: Adult results, Paucal

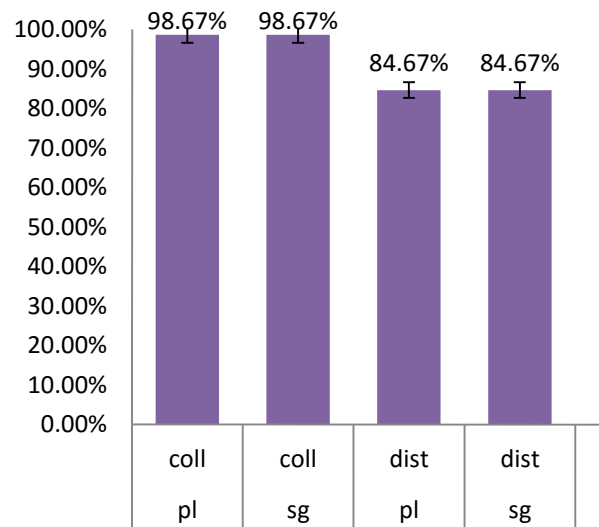


Figure 4.b: Children results, Paucal

4.2.2. Experiment 2, Mixed-gender – Adults and children

The mixed-gender experiment showed a similar comparison between adults and children (Figure 4 – YES responses). However, in the best fitting models for this experiment, verbal agreement was not a significant factor. Adults were still likely to reject singular agreement which is in line with the result from the pilot (i.e. plural verbal agreement is preferred) but not the established theories (i.e. singular verbal agreement is the default agreement for mixed-gender numerals). As expected, adults were significantly more likely to reject distributive pictures in general (Est: -6.86890; $p < 0.000$) unlike children (Est: 3.9109; $p < 0.106$). There are, however, a few notable remarks that are different from Experiment 1. Children almost equally accepted all pictures, proving that this group of children was still not thinking in terms of overt markers or singularity of objects, which will be covered in the Discussion. Second, adults did not reject singular verbal agreement, showing again (congruent to the naturalness study) that both agreements are equally valid, unlike with paucals.

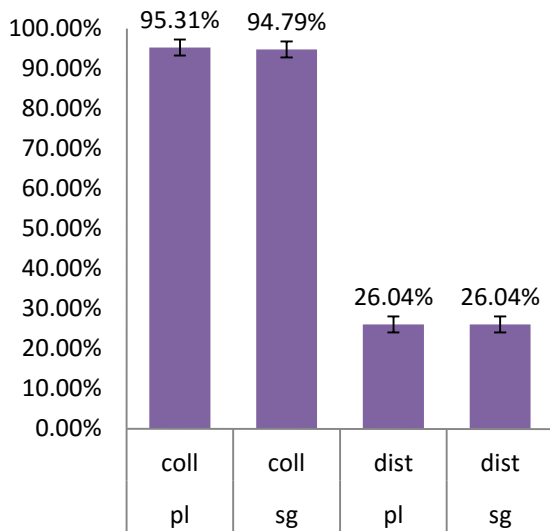


Figure 5.a: Adult results, Mixed-gender

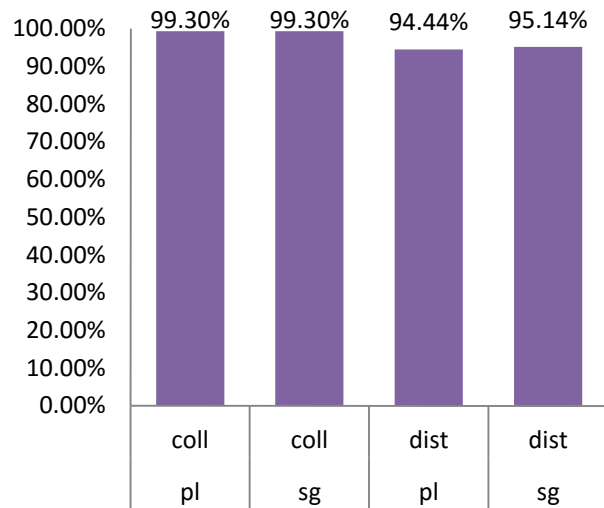


Figure 5.b: Children results, Mixed-gender

5. Discussion

Contrary to our predictions, we saw no sensitivity to verbal agreement in regards to collective/distributive reading – verbal agreement may not be strong enough of a cue to disambiguate sentences. However, it is important to note that answers could be influenced by factors we did not control for, such as world knowledge, discourse and types of predicates¹⁵.

If we, for example, focus on the Serbian adult results only, we see almost complete rejection of distributive interpretations. English adults would not reject distributivity at such a high rate; for them, numerically quantified sentences are ambiguous, but with a preference towards collectivity (Musolino, 2009; Syrett and Musolino, 2013). For Serbian adults, this is not the case – it looks like distributive interpretation is marginal, if not incorrect. We are still faced with a question - What makes Serbian system so different from English? It is possible that morpho-syntactic marking could, in theory, still play a role, since the current study suffered some design flaws. Different experimental designs could be established to further pursue this hypothesis. However, we would have expected at least some indication of an effect, but there was none.

Maybe the Serbian system might differ from English because Serbian has different distributive markers available in the language. From previous studies we know that Serbian has distributive quantifiers and distributive markers, such as *po*. Knežević (2015) claims that the marker *po* is a distributive-share marker, while English lacks distributive-share markers. Distributive-share markers modify the element that is distributed, and not the element it is distributed over. The presence of *po* in Serbian, however, may cause Serbian adults to reject distributive pictures because more informative and prominent ways of conveying the distributive reading are available in the language. Having *po* in a sentence blocks collective interpretations and it is then expected that the lack of *po* would block distributive interpretations. An analysis along similar lines has already been proposed in Pagliarini et al. (2012). They argue that definite plural or numerically quantified expressions, which can be ambiguous for collective and distributive reading, can instead be interpreted as strongly collective by adults via a scalar implicature: because there is another, more explicit way of conveying the message with distributive meaning (i.e. marking it with *each*). However, if that marking is not present the speaker must not intend a distributive reading. This proposal thus claims that semantically, both readings are possible, but pragmatic reasoning disambiguates the sentence. This same reasoning could easily account for Serbian as well (10):

¹⁵ This is one of the reason we are planning follow up experiments which will control for these factors and show production data from Serbian adults and children. These will clarify which verbal agreement is truly dominant in adult and child language and whether there are some conditional preferences towards one or another.

- (10) a. Tri klovna nose poklon.
 Three.pauc clown.pauc carry.pl present.sg
 “Three clowns are carrying a present” OK collective/ ??distributive
 b. Tri klovna nose po poklon.
 Three.pauc clown.pauc carry.pl DIST present.sg
 “Three clowns are each carrying a present” *collective/ OK distributive

Even though adults judge the distributive reading marginal in (10a), it is still available. *Po*, on the other hand, makes collective interpretation impossible. A hearer interpreting (10a) may consider the fact that the speaker did not say (10b) as evidence that the collective reading is probably intended. So far, this seems like a good explanation of the results and differences between the speakers of languages with less marking and with more complex marking in morpho-syntax. But what about children and how do we explain their results?

We know that Serbian children prefer distributive readings for sentences without a distributive marker at age 5, as it is evident from the study by Knežević (2012) (Figure 2). Our study, however, shows that they still choose distributive readings at age 7 (Figures 4 and 5) which is when English speaking children have become almost adult-like. If we take the complexity of the system and markedness into account, we should see a more delicate sensitivity to different linguistic markers, and keeping in mind that *po* is highly informative, children should have been able to be sensitive to it. Since this is not the case, it is possible that the problem is with numerous meanings of *po*, and form-to-meaning relation, which is one-to-many in case of *po* (van Hout, 2008). Not only that, we also believe that due to the complexity of the system, children have an increased cognitive load, which results in incorrect responses and late acquisition of certain markers.

This account would predict that manipulating the cognitive load of experimental participants should have an effect on interpretation preference. For example, Van Rij et al. (2009) found that for pronoun processing, slowing down the presentation of experimental stimuli decreases the working memory load for children and caused them to behave more adult-like. The opposite can be done with adults. We can increase their working memory load with additional tasks to see if their performance alters towards being more child-like.

Although this speculation explains some discrepancies in the results, there is one more instance we need to cover. Comments by participants suggest that the singularity of the object in the sentences is the reason for rejecting distributive pictures. Our experiments had a singular object, which we primarily chose to avoid confusion with cases of cumulativity. In addition, singular indefinite objects allow atomic (individual) interpretations, since singularity generally endorses distributivity. Moreover, a few online studies, such as the on-line reading study by Patson and Warren (2010) showed that singular indefinite noun phrases within a distributed predicate can be interpreted as conceptually plural.¹⁶ A singular indefinite noun X can have wide (one) and narrow (many) scope readings, meaning it can refer to either one X (collective) or many X (distributive) (Perez-Leroux, 2005) (11):

- (11) Three girls own a dog.
 Wide scope (collective): there is only one dog and it is owned by three girls.
 Narrow scope (distributive): there are three dogs and each girl owns one dog.

For both our experiments we expected that children would say YES to all conditions, given the results from previous studies. Whenever a child said NO and showed a more adult-like behavior, the experimenter asked why. The response was always related to the fact the object was in singular and the correct way would be to put it in plural for distributive pictures. We illustrated this instance below (12):

¹⁶This study, however, is inconsistent with the eye-tracking study by Paterson et al. (2008), in which they concluded that participants did not interpret singular indefinites as conceptually plural because it took longer to process plural anaphors referring to the indefinite noun phrases. Patson and Warren do think it has to do with slightly different stimuli – they used shorter sentences with a bias towards the reading where singular indefinite noun phrases fall under the scope of a distributive quantifier, while Paterson et al. had much longer sentences with full ambiguity.

(12)



Troje Štrumpfova nosi ogledalo.

“Three Smurfs are carrying a mirror”

Child: No, because they are carrying three mirrors.

Only 6 out of 49 children explicitly discussed the indefinite singular object as a reason for rejecting distributive interpretations. We can now say that children did not reject pictures (there were no extra agents or extra objects), but actually sentences, so this cannot be the case of spreading – errors children are making when they reject universally quantified sentences because there are additional objects (Brooks and Braine, 1996). What can be concluded is that Serbian children reject distributive pictures with sentences with singular indefinite objects. Singular indefinite noun phrases therefore cannot be interpreted as (conceptually) plural, which is in contrast with known on-line and off-line empirical data. How do we explain this?

There is a view that supports cognitive load for children and conversational implicatures for adults. It is important to note that using the plural form of the object in the target sentences (e.g. “Three Smurfs are carrying mirrors.”) is far more informative in favor of distributive scenarios than using the singular object, which has to be interpreted as conceptually plural. Thus, a child would prefer rephrasing and simplifying the sentence to get the distributive reading, rather than go through a cognitive process of interpreting singular as conceptually plural to obtain the same effect. On the other hand, there is an alternative explanation: perhaps children do not realize that singular indefinites can be interpreted as plural. This seems highly unlikely, even though we do not have evidence that adults think in a similar fashion, so we cannot claim adults would not reject distributive pictures because of the singularity. Since we know that children are generally bad with scalar and conversational implicatures (Mirić and Arsenijević, 2013) at a younger age, maybe the simplest explanation is that interpreting singular as conceptually plural is no more than a language development stage that children have not yet reached.

6. Conclusion

In this study, we investigated the correlation between verbal agreement and distributivity/collectivity preference in adults and 7-year-old children in Serbian. We did not find any significant effect of verbal agreement (nor nominal inflections) on particular interpretations, thus morpho-syntactic inflections might not be strong markers for distributivity and collectivity, contrary to what has been proposed in Lebanese Arabic (Ouwayda, 2014). We proposed an alternative explanation in which adults understand numerically quantified sentences without distributive markers as scalar implicatures – since there is a better alternative to convey a distributive message, numerically quantified sentences must be collective. For children, however, we suspect that complex morpho-syntactic system of Serbian is loading children’s working memory, and it is affecting the processing of such ambiguous sentences. Future work should look into the matter of cognitive load, as well as try to rank distributive markers crosslinguistically.

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8. Appendixes

Appendix A

Experiment 1a – Paucal numerals, adults: Fixed effects of the best fitting linear mixed effect model:

Formula:

Answer ~ Agree + Picture + (1 + Picture | Question) + (1 + Picture * Agree | ID)

Fixed effects:

Predictor	Estimate	SE	z value	p-value
(Intercept)	7.698310	0.001507	5110	<0,000
Verb singular	-1.154014	0.001507	-766	<0,000
Distributive picture	-9.521166	0.001507	-6320	<0,000

Experiment 1b – Paucal numerals, children: Fixed effects of the best fitting linear mixed effect model:

Formula:

Answer ~ Agree + Picture + (1 + Picture | ID)

Fixed effects:

Predictor	Estimate	SE	z value	p-value
(Intercept)	4.313	0.5588	7.718	<0,000
Verb singular	-0.000000865	0.4650	0.000	1.000
Distributive picture	2.677	2.350	1.139	0.255

Appendix B

Experiment 2a – Mixed gender numerals, adults: Fixed effects of the best fitting linear mixed effect model:

Formula:

Answer ~ Agree + Picture + (1 + Picture | Question) + (1 + Picture | ID)

Fixed effects:

Predictor	Estimate	SE	z value	p-value
(Intercept)	4.89691	1.08941	4.495	<0.000
Verb singular	-0.02111	0.30307	-0.070	0.944
Distributive picture	-6.86890	1.21018	-5.676	<0,000

Experiment 2b – Mixed gender numerals, children: Fixed effects of the best fitting linear mixed effect model:

Formula:

Answer ~ Agree + Picture + (1 + Picture | ID)

Fixed effects:

Predictor	Estimate	SE	z value	p-value
(Intercept)	4.8420	0.7763	6.237	<0,000
Verb singular	0.2580	0.7210	0.358	0.720
Distributive picture	3.9109	2.4184	1.617	0.106

Appendix C

List of target items:

PAUCAL NUMERALS a – singular verb b – plural verb	MIXED-GENDER NUMERALS a – singular verb b – plural verb
1a. Tri vanzemaljca je nosilo merdevine.	1a. Troje vanzemaljaca nosi merdevine.
1b. Tri vanzemaljca su nosila merdevine.	1b. Troje vanzemaljaca nose merdevine.
2a. Tri klovna je držalo poklon.	2a. Troje dece drži poklon.
2b. Tri klovna su držala poklon.	2b. Troje dece drže poklon.
3a. Tri psa je vuklo sanke.	3a. Troje dece vuče sanke.
3b. Tri psa su vukla sanke.	3b. Troje dece vuku sanke.
4a. Tri slona je guralo kamen.	4a. Troje Štrumpfova gura kamen.
4b. Tri slona su gurala kamen.	4b. Troje Štrumpfova guraju kamen.
5a. Tri vanzemaljca je držalo sto.	5a. Troje vanzemaljaca drži sto.
5b. Tri vanzemaljca su držala sto.	5b. Troje vanzemaljaca drže sto.
6a. Tri klovna je guralo orman.	6a. Troje ljudi gura orman.
6b. Tri klovna su gurala orman.	6b. Troje ljudi guraju orman.
7a. Tri klovna je nosilo kofer.	7a. Troje dece nosi kofer.
7b. Tri klovna su nosila kofer.	7b. Troje dece nose kofer.
8a. Tri slona je držalo granu.	8a. Troje Štrumpfova drži granu.
8b. Tri slona su držala granu.	8b. Troje Štrumpfova drže granu.
9a. Tri vanzemaljca je vuklo prikolicu.	9a. Troje vanzemaljaca vuče prikolicu.
9b. Tri vanzemaljca su vukla prikolicu.	9b. Troje vanzemaljaca vuku prikolicu.
10a. Tri klovna je guralo auto.	10a. Troje ljudi gura auto.
10b. Tri klovna su gurala auto.	10b. Troje ljudi guraju auto.
11a. Tri psa je nosilo korpu sa voćem.	11a. Troje dece nosi korpu sa voćem.
11b. Tri psa su nosila korpu sa voćem.	11b. Troje dece nose korpu sa voćem.
12a. Tri slona je vuklo brod.	12a. Troje ljudi vuče brod.
12b. Tri slona su vukla brod.	12b. Troje ljudi vuku brod.
13a. Tri psa je nosilo automobilsku gumu.	13a. Troje Štrumpfova nosi automobilsku gumu.
13b. Tri psa su nosila automobilsku gumu.	13b. Troje Štrumpfova nose automobilsku gumu.
14a. Tri vanzemaljca je držalo zastavu.	14a. Troje vanzemaljaca drži zastavu.
14b. Tri vanzemaljca su držala zastavu.	14b. Troje vanzemaljaca drže zastavu.
15a. Tri klovna je vuklo autić.	15a. Troje dece vuče autić.
15b. Tri klovna su vukla autić.	15b. Troje dece vuku autić.

16a. Tri psa je guralo kolica za bebe.	16a. Troje dece gura kolica za bebe.
16b. Tri psa su gurala kolica za bebe.	16b. Troje dece guraju kolica za bebe.
17a. Tri slona je držalo lampu.	17a. Troje ljudi drži lampu.
17b. Tri slona su držala lampu.	17b. Troje ljudi drže lampu.
18a. Tri vanzemaljca je guralo stolicu.	18a. Troje vanzemaljaca gura stolicu.
18b. Tri vanzemaljca su gurala stolicu.	18b. Troje vanzemaljaca guraju stolicu.
19a. Tri slona je nosilo stablo.	19a. Troje ljudi nosi stablo.
19b. Tri slona su nosila stablo.	19b. Troje ljudi nose stablo.
20a. Tri psa je držalo kost.	20a. Troje Štrumpfova drži kost.
20b. Tri psa su držala kost.	20b. Troje Štrumpfova drže kost.
21a. Tri slona je vuklo voz.	21a. Troje ljudi vuče voz.
21b. Tri slona su vukla voz.	21b. Troje ljudi vuku voz.
22a. Tri vanzemaljca je guralo kolica.	22a. Troje vanzemaljaca gura kolica.
22b. Tri vanzemaljca su gurala kolica.	22b. Troje vanzemaljaca guraju kolica.
23a. Tri klovna je nosilo ogledalo.	23a. Troje Štrumpfova nosi ogledalo.
23b. Tri klovna su nosila ogledalo.	23b. Troje Štrumpfova nose ogledalo.
24a. Tri psa je vuklo kočiju.	24a. Troje Štrumpfova vuče kočiju.
24b. Tri psa su vukla kočiju.	24b. Troje Štrumpfova vuku kočiju.